CANADIAN PETROLEUM ASSOCIATION

PETROLEUM-RELATED ACTIVITY AND RESOURCE POTENTIAL WITHIN THE BEAUFORT SEA - MACKENZIE DELTA LAND USE PLANNING AREA

prepared for

THE CANADIAN PETROLEUM ASSOCIATION

by

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SUMMARY

The Mackenzie Delta-Beaufort Sea Regional Planning Commission is working toward completion of a regional land use plan and has approached the Canadian Petroleum Association seeking information on industry plans and land use requirements. This report has been prepared in response to that request. The report consolidates information about the petroleum industry's past and current activity within the boundaries set out for consideration by the planning commission. It also describes the likely nature and scope of future petroleum industry development and land use in the region.

The Mackenzie Delta-Beaufort Sea planning region extends from a point just south of the communities of Fort McPherson and Arctic Red River in the Mackenzie River Valley, north to Borden Island at the northwestern edge of the Queen Elizabeth Islands. The region is bounded on the west by the Yukon Territory border and on the east by the Melville Hills and Victoria Island.

Petroleum industry activity in the region has centered on the Mackenzie Delta and southern Beaufort Sea, and on the western extension of the Sverdrup Basin in the vicinity of Melville Island. Exploration drilling completed to date has resulted in the discovery of substantial oil and natural gas reserves in both areas.

There have been a number of proposals put forward to transport oil and gas resources from the Mackenzie Delta and Beaufort Sea area and more recently from Melville Island. Although petroleum industry activity in the planning region has declined over the last several years, it is believed that improved market opportunities for oil and gas will spur renewed interest. As a consequence, both oil and gas pipeline systems are expected to be in place and operating before the end of the century. Transport of oil from the southern Beaufort Sea using ice-breaking tanker ships has also been considered and may follow pipeline development. A gas pipeline from the high arctic near Melville Island can be expected in the longer term.

Facilities to produce, process and transport oil and gas from the Mackenzie-Beaufort area will likely take a form that will allow development of both onshore and offshore reserves. Gas production will most likely first involve onshore gas plants at the two major gas fields on Richards Island (Niglintgak and Taglu) together with a third at Parsons Lake on the mainland. Subsequent development will entail the connection of smaller

onshore, and eventually offshore, reserves by extending gathering systems from the three gas plants. A possible alternate approach to gas development would involve a single, centrally-located, gas plant that would serve the three major onshore gas fields and eventually other, smaller onshore and offshore discoveries. Oil reserves will most likely be first produced from offshore wells at Amauligak and will be brought ashore by subsea pipeline to a terminal on northern Richards Island. As with gas development, subsequent oil development will involve connection of smaller onshore and offshore reserves to installed processing and transport facilities. The construction of oil and gas pipelines and processing facilities is expected to rekindle interest in exploration in the region.

Full development of petroleum reserves in the region will require that lands with hydrocarbon potential continue to be made available for exploration, and that reasonable access to those lands be assured. In planning the use of land it will be necessary to recognize the importance of transportation corridors into and out of the region. In addition, land use planners will have to ensure that certain lands uniquely valuable to the petroleum industry are protected from encroachment by non-compatible land uses. Lands in this category include sites where significant petroleum reserves have been discovered and deep water harbour sites along the Beaufort Sea coast.

The Canadian Petroleum Association recommends that the planning commission adopt a concept of multiple land use which will recognize and allow the greatest number of compatible land uses. The association also recommends that the regional land use plan incorporate sufficient flexibility to deal with unexpected situations, and a clearly-defined process by which it can be reviewed and refined.

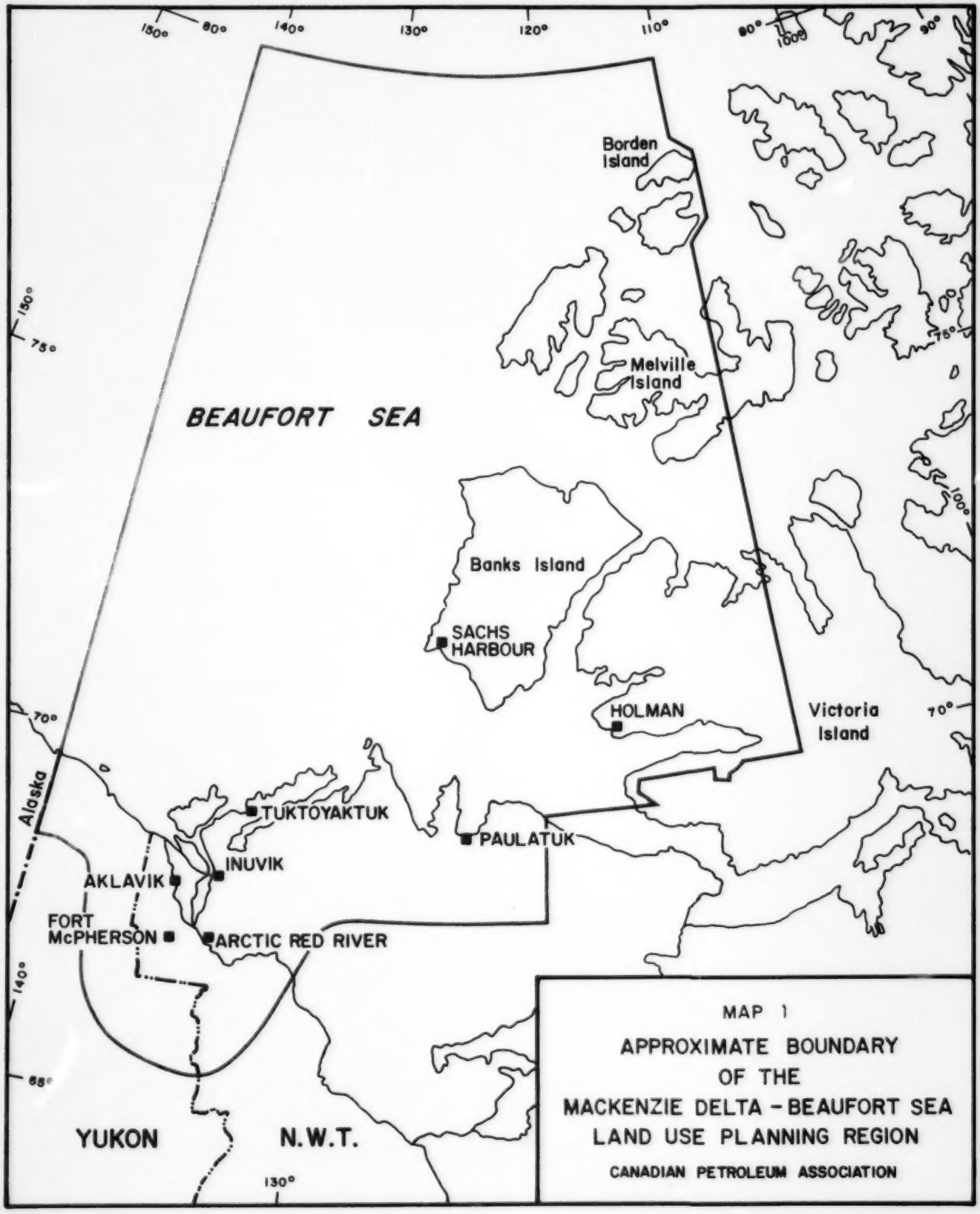
INTRODUCTION

This report has been prepared on behalf of the Canadian Petroleum Association for use by the Mackenzie Delta-Beaufort Sea Regional Planning Commission. It consolidates information about the petroleum industry's past and current activity and land use within the boundaries set out for regional planning by the commission. The nature and scope of likely future petroleum development and related land use is described and a brief discussion of how the petroleum industry hopes to respond to land use planning is included.

The description of likely future petroleum development presented in this report is based on plans currently being put forward by a number of separate companies. As a result, the overall nature of development plans for the region is somewhat speculative, and as presented here, includes overlapping and in some cases, potentially conflicting proposals. This undesirable situation is expected to improve as companies with common interests begin to integrate their plans. The result of such integration will likely be the cooperative development of a number of processing, support and transport facilities, and an overall reduction in the number of such installations in the region. Unfortunately, it is too early in the planning process for individual companies to have looked closely at possible integratation.

The Mackenzie Delta-Beaufort Sea Regional Planning Commission was appointed by the federal Minister of Indian and Northern Affairs in June of 1987 and was charged with the task of developing a regional land use plan. The geographic area included in the planning region is shown by **Map 1**. Land use planning for the Mackenzie-Beaufort Sea region is part of a wider effort which will in time involve all of the Northwest Territories. One other regional planning commission is presently active and others will be formed. Once in place, a regional land use plan will serve as a reference for the administration of land by existing federal, territorial and regional agencies charged with that responsibility.

Although the petroleum industry has been active in the Mackenzie-Beaufort region only since the late 1950s, it has in that short period become an important user of land, and has played a major role in transforming the economy of the region. The importance of the petroleum industry as an economic force and as a user of land in the region will increase in the future.


150°
140°
130°
120°
110°
100°
90°
80°
75°
70°
Borden Island
Melville Island
BEAUFORT SEA
Banks Island
SACHS HARBOUR
HOLMAN
Victoria Island
Alaska
TUKTOYAKTUK
PAULATUK
INUVIK
AKLAVIK
FORT McPHERSON
ARCTIC RED RIVER
YUKON
N.W.T.
MAP 1
APPROXIMATE BOUNDARY
OF THE
MACKENZIE DELTA - BEAUFORT SEA
LAND USE PLANNING REGION
CANADIAN PETROLEUM ASSOCIATION

PAST PETROLEUM INDUSTRY ACTIVITY IN THE PLANNING REGION

Potential hydrocarbon deposits in Canada's north were first noted by Alexander Mackenzie during his voyage of discovery along the river which now bears his name. At a location near the present day community of Norman Wells, Mackenzie reported finding "petroleum-like pieces of yellow wax". One hundred and twenty-five years later, in 1919, mineral claims were staked along the river near the same location. Drilling followed in the same year and oil was discovered in 1920 by Imperial Oil Ltd. A topping plant was constructed in 1921 and the oil field which was to become known as the Norman Wells field has since supplied regional fuel requirements.

Interest in northern hydrocarbons continued to be centered on the Norman Wells field, and remained at a low ebb, until the second World War sparked additional drilling in the field, the construction of a refinery and the completion of the Canol Pipeline to carry refined products to Whitehorse in Yukon Territory. The pipeline was operated only briefly. In 1975, further delineation drilling led to full-scale development of the Norman Wells field. A pipeline to carry the produced oil to market was built by Interprovincial Pipe Line Ltd. from Norman Wells to Zama Lake in northern Alberta. The latter pipeline began operating in 1985.

Interest in petroleum exploration within the boundaries of the Mackenzie Delta-Beaufort Sea planning region occurred simultaneously in two widely-separated areas. The first exploratory well drilled within the planning region was completed in 1961 by Dome Petroleum at Winter Harbour on Melville Island. In the southern part of the planning region, geophysical surveys in the Mackenzie Delta area in 1958 and 1959 led to the initiation of exploration drilling in 1962. In the case of Mackenzie Delta and Beaufort Sea area, most subsequent petroleum activity has remained within the planning region's boundaries. That has not been the case with exploration in the Melville Island area, where subsequent drilling has for the most part been north and east of the planning region's boundary.

Petroleum Activity in the Mackenzie Delta-Beaufort Sea Area

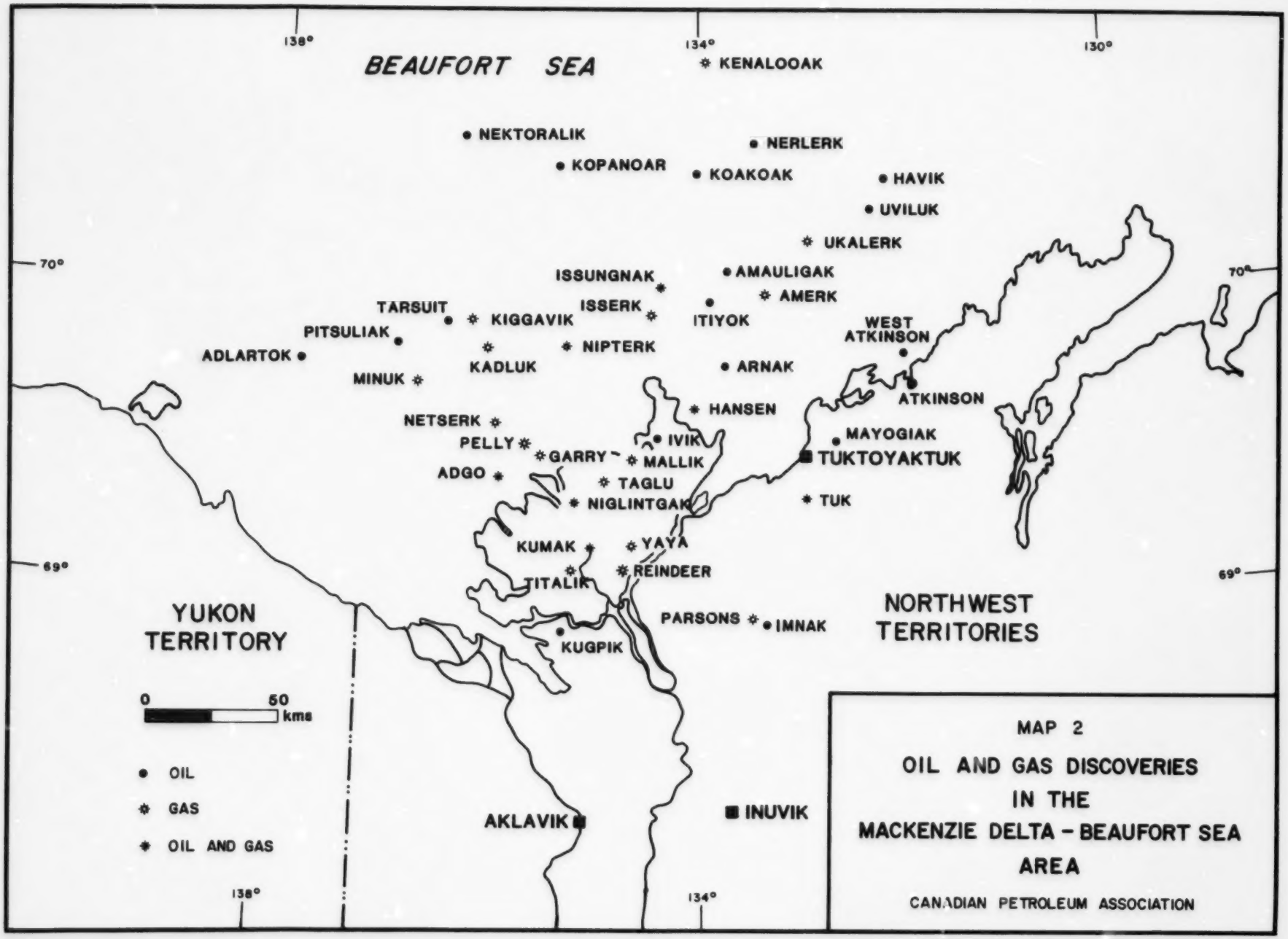
The search for petroleum in the Mackenzie Delta area began in the late 1950s, spurred on in part by promising results from exploratory drilling in both the Norman Wells area to the south and Yukon Territory to the west. Geophysical surveys were initiated in the Mackenzie Delta in 1958 and in

1959 extended to nearshore areas of the Beaufort Sea. Shell Canada Limited, Gulf Oil Canada Limited and Imperial Oil Ltd. obtained rights to large tracts of land in the delta area and exploratory drilling began in 1962. By 1968, 38 wells had been drilled in northern mainland areas but none had discovered significant amounts of oil or gas. Those early wells, however, did confirm and extend interpretations of the region's geology. In 1968, oil was discovered in Prudhoe Bay on the Alaskan Beaufort Sea coast and that event spurred further seismic and exploration activity in the delta. The first significant discovery of oil in the planning region was made in 1970 by Imperial Oil Limited at the Atkinson H-25 well on the Tuk Peninsula. The following year, a large gas field was discovered on Richards Island near the northern edge of the delta by Imperial Oil Ltd.

Exploration moved to the shallow nearshore waters of the Beaufort Sea in 1973 when Imperial Oil Ltd. constructed an artificial island for use as a drilling platform. Other drilling followed in the shallow water off the delta and, as drilling experience was gained in nearshore areas, drilling efforts were extended to deeper waters. Drilling in the Beaufort Sea using drillships was initiated by Dome Petroleum in 1976. To date, approximately 170 wells have been drilled at onshore locations in the delta region, while about another 70 have been drilled in the southern Beaufort Sea.

Exploration effort expended in the Mackenzie Delta-Beaufort Sea area has resulted in significant discoveries of both oil and gas, even though exploration of the sedimentatary basin involved is only in its early stages. The locations of drill sites where signficant discoveries have been made, are shown on **Map 2**. Geophysical surveys have been completed over most of the onshore Mackenzie Delta and adjacent Tuk Peninsula and have been extended over much of the submerged delta lying offshore. Exploration interest has remained highest, however, in the region of the delta and southern Beaufort Sea. **Map 3** shows the approximate boundary of the lands which have recently been explored in the Mackenzie Delta area.

Discovered reserves of recoverable oil in the Mackenzie Delta and southern Beaufort Sea are estimated by the Geological Survey of Canada to total 117 million cubic metres (approximately 736 million barrels), a quantity equal to about 10 percent of the known reserves of recoverable conventional oil in all of Canada. Estimates of the amount of oil that might yet be discovered in the area are much greater, amounting to between 20 and 30 percent of Canada's future supplies. These estimates do not take into consideration non-conventional oil reserves which exist as heavy oil or tar sands.


BEAUFORT SEA
138°
134°
130°
70°
69°
KENALOOAK
NEKTORALIK
NERLERK
KOPANOAR
KOAKOAK
HAVIK
UVILUK
UKALERK
AMAULIGAK
AMERK
ISSUNGNAK
ISSERK
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ADLARTOK
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ARNAK
MINUK
WEST ATKINSON
ATKINSON
HANSEN
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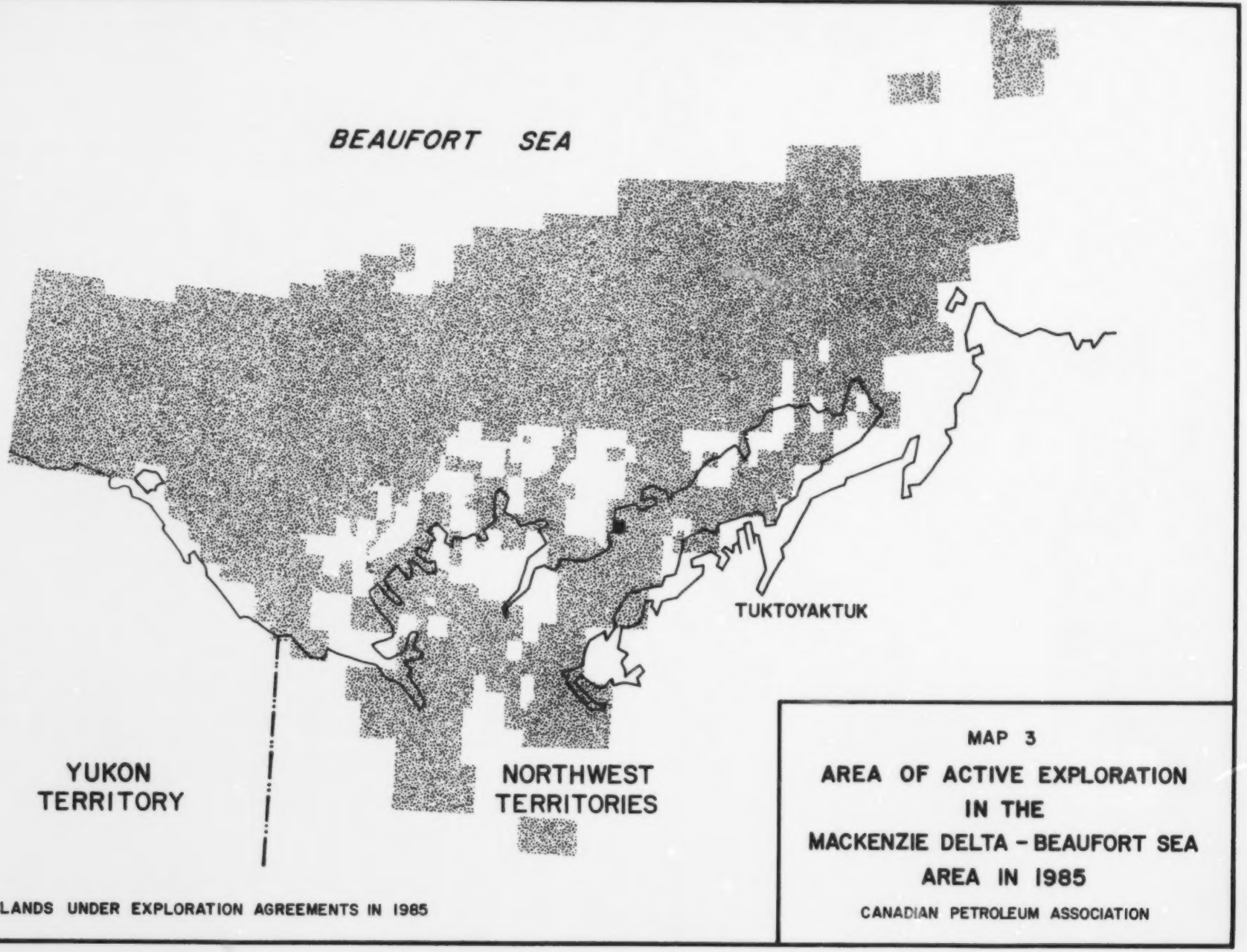
PELLY
IVIK
MAYOGIAK
GARRY
MALLIK
TUKTOYAKTUK
ADGO
TAGLU
NIGLINTGAK
TUK
KUMAK
YAYA
REINDEER
TITALIK
PARSONS
IMNAK
KUGPIK
YUKON TERRITORY
NORTHWEST TERRITORIES
0
50
kms
OIL
GAS
OIL AND GAS
AKLAVIK
INUVIK
MAP 2
OIL AND GAS DISCOVERIES
IN THE
MACKENZIE DELTA - BEAUFORT SEA
AREA
CANADIAN PETROLEUM ASSOCIATION



MAP 3

AREA OF ACTIVE EXPLORATION IN THE MACKENZIE DELTA - BEAUFORT SEA AREA IN 1985

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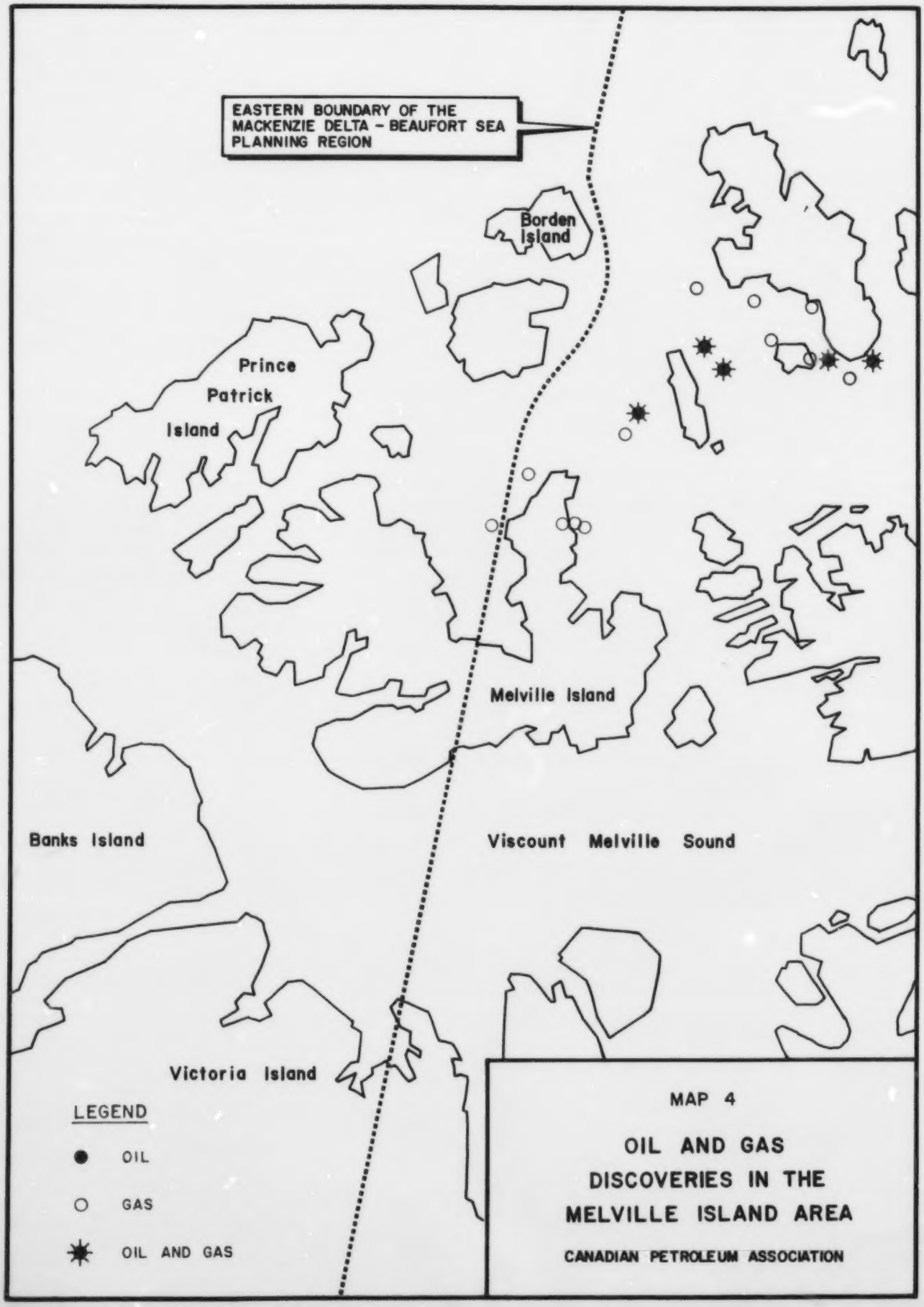
Gas discoveries in the region are believed to be of similar importance, on a national scale, as the reserves of oil so far discovered. Estimates of the quantity of recoverable natural gas discovered to date in the Mackenzie Delta and southern Beaufort Sea total 286 billion cubic metres (10.1 trillion cubic feet), a quantity equal to approximately 10 percent of the known reserves of natural gas throughout all of Canada. Undiscovered natural gas in the area is thought to represent approximately 20 percent of Canada's future supply.

Petroleum Activity in the Melville Island Area

Concerted efforts to determine the oil and gas potential of Canada's Arctic Archipelgo began in 1955 when the federal government initiated geological surveys in the region. Efforts by private interests to explore the region began several years later. The results of early survey efforts suggested that the potential for hydrocarbon deposits in the area was high, and in 1961, Dome Petroleum drilled a well at Winter Harbour on the south coast of Melville Island. At about the same time, a tar sand deposit, estimated to contain 16 million cubic metres (100 million barrels) of oil, was discovered on the northern side of Melville Island. Exploration drilling efforts moved north and east in 1969, into a geological area known as the Sverdrup Basin. One of three wells drilled that year discovered a large gas field. Further drilling in the area over the intervening years has resulted in a series of discoveries of both oil and gas but for the most part these have been outside the planning region. As in the Mackenzie Delta area, exploration in Canada's northern islands has declined in recent years. The locations of major discoveries in the area are shown on **Map 4** and the extent of recent exploration activity is shown on **Map 5**.

Recoverable reserves so far discovered in Canada's Arctic Islands are estimated to total 76 million cubic metres (478 million barrels) of oil and 361 billion cubic metres (12.8 trillion cubic feet) of natural gas. Those reserves represent approximately six percent of the known recoverable oil and 12 percent of the known recoverable natural gas remaining in Canada. As with the Mackenzie Delta and southern Beaufort Sea area, it is anticipated that large quantities of both oil and natural gas have yet to be discovered in the arctic islands. Current estimates suggest that future oil discoveries in the area will account for approximately seven percent of Canada's total supply and that future discoveries of natural gas will represent as much as 22 percent of the nation's total supply.


EASTERN BOUNDARY OF THE MACKENZIE DELTA - BEAUFORT SEA PLANNING REGION
Borden Island
Prince Patrick Island
Melville Island
Banks Island
Viscount Melville Sound
Victoria Island
LEGEND
OIL
GAS
OIL AND GAS
MAP 4
OIL AND GAS DISCOVERIES IN THE MELVILLE ISLAND AREA
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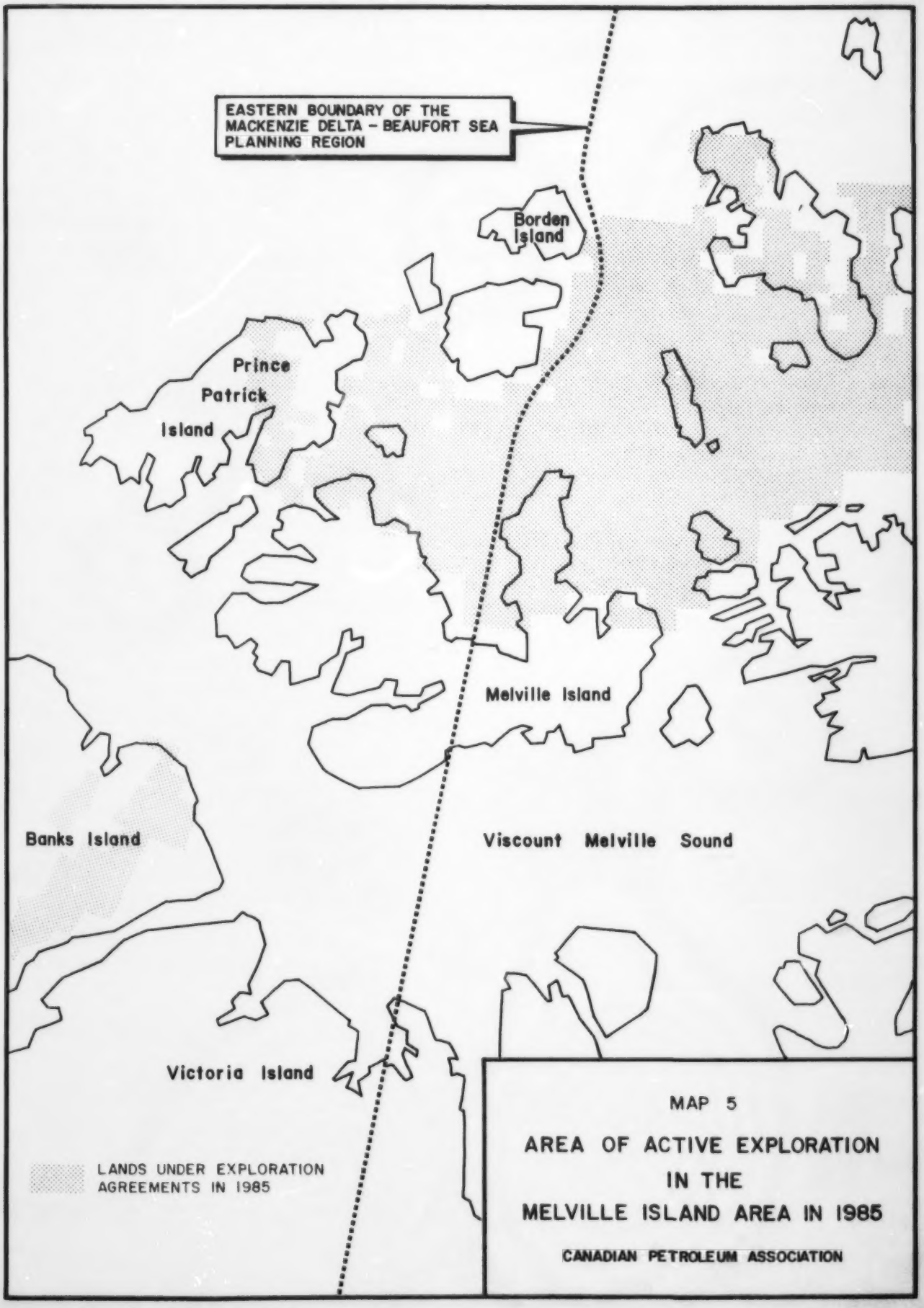
EASTERN BOUNDARY OF THE MACKENZIE DELTA - BEAUFORT SEA PLANNING REGION
Borden Island
Prince Patrick Island
Melville Island
Banks Island
Viscount Melville Sound
Victoria Island
LANDS UNDER EXPLORATION AGREEMENTS IN 1985
MAP 5
AREA OF ACTIVE EXPLORATION IN THE MELVILLE ISLAND AREA IN 1985
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Most of the potential reserves estimated for the arctic islands are thought to exist in the Sverdrup Basin, a geological area which lies only in part within the Mackenzie Delta-Beaufort Sea planning region.

Petroleum Activity on Banks Island and the Mainland

In addition to the intense oil and gas exploration activity that has taken place in the planning region within the Mackenzie Delta, Beaufort Sea and Melville Island areas, there have been other exploration efforts on northeastern Banks Island, and on the mainland, in an area lying south of the Parry Peninsula.

Exploration permits for lands on Banks Island were first obtained in 1964 and seismic surveys, which were begun in the late 1960s, and continued through the next decade. Exploration drilling began in 1972 and came to an end in 1982. Eleven exploratory wells were drilled but no discoveries of oil or gas resulted. At present there is no exploration activity in the area.

Exploration of lands south of the Parry Peninsula on the mainland has resulted in several significant discoveries of natural gas. Activity in this area has for the most part taken place outside the boundaries of the planning region. Nevertheless, future activity may have some degree of influence on land use within the planning region.

PAST AND CURRENT PETROLEUM-RELATED LAND USE IN THE REGION

The petroleum industry's interest in the planning region has to date been directed toward exploration rather than development, and industry activity has consisted primarily of seismic surveys and exploration drilling. As a consequence, land use associated with past and current activity has, and continues to be, temporary in nature.

Seismic Surveys

Seismic surveys completed in the planning region have involved mainland areas, the Mackenzie Delta, the southern Beaufort Sea, parts of Banks Island and much of the Melville Island area. Surveys on land have in most cases been completed in winter over frozen ground and have been based from mobile camps pulled by tracked vehicles. In offshore areas, seismic surveys have

been carried out from marine vessels. To date several hundred thousand kilometres of seismic survey have been completed within the planning region.

By their nature seismic surveys are self-sufficient and those carried out in the planning region have not required the establishment of support camps. Most seismic programs have been staged from communities in the region, using existing infrastructure. Land use for seismic exploration has been limited to the disturbance caused by the movement of men and equipment along survey lines and that caused by the drilling of shot holes. In contrast, exploration drilling has required the establishment of temporary support facilities and a much wider range of land uses.

Exploration Drilling

Exploration drilling in the planning region has been completed on-land and at offshore locations and has taken a variety of forms, reflecting not only the geology of the formations being explored but also surface conditions, season of operation, available equipment and land use restrictions in force. In northern mainland areas drilling has most often been carried out in winter to take advantage of easier transport of heavy equipment over frozen ground and the relatively simple clearing and grading required to prepare a winter drill site. In the Mackenzie Delta region, drilling has been carried out from thick gravel pads or alternatively from platforms placed on piles; both being approaches designed to prevent thawing of ice-rich ground. Access to drill sites in the delta area has been via winter roads over ice or frozen ground, by helicopter or by river barge. Drilling in offshore areas has taken place from artificial islands constructed from bottom sediments, from special temporarily-anchored drilling structures and from drill ships in deeper waters. Drilling in the Sverdrup Brasin, in the most northern part of the planning region, has in some instances been completed from artificially-thickened sea-ice platforms.

More than 200 exploratory wells have been drilled in the planning region under existing regulations. With few exceptions past drilling efforts have been completed without significant problems or disruption to other land uses.

Exploration drilling in the Mackenzie Delta and the Tuk Peninsula required the establishment of temporary base/support facilities at Point Farewell, Tununuk Point and Swimming Point, as well as the establishment of camp, storage and transhipping facilities at both Inuvik and Tuktoyaktuk.

Preparation of some drill sites also required the mining of gravel deposits at Ya Ya Lake. Drilling operations were supported by aircraft, river barges, tugs and smaller vessels and by winter truck traffic over ice and snow roads throughout the region.

Exploratory drilling in the southern Beaufort Sea initially involved support from the same bases as onshore drilling, but as exploration efforts moved further offshore, support was supplied largely from Tuktoyaktuk, McKinley Bay, Herschel Basin, and from large marine vessels. Temporary facilities at Summers Harbour and Wise Bay, located at the northern tip of the Parry Peninsula, were also used in support of past offshore exploration.

FUTURE PETROLEUM ACTIVITY IN THE PLANNING REGION

To date, petroleum exploration in the planning region has been spurred by the possibility of finding substantial petroleum resources and the belief that transport systems to move these resources to market will be developed. At present, exploration activity in the region is at a low ebb, due primarily to uncertainty about the future price of petroleum products on world markets. For petroleum activity in the region to progress beyond the exploration phase that has been experienced to date, production and transport systems will have to be put in place. It is expected that the successful installation of one or more production and transport systems will cause renewed interest in the area, spur a new wave of exploration and will generate a greatly increased level of petroleum industry activity.

Proposals for Transporting Hydrocarbons

A number of proposals to move hydrocarbon resources from the Mackenzie Delta and southern Beaufort Sea have been put forward over the years. Some proposals have been subjected to considerable study, while others remain at the pre-feasibility stage. Two proposals to move Mackenzie Delta and Beaufort Sea gas to market using pipelines are presently the subject of separate applications before the National Energy Board.

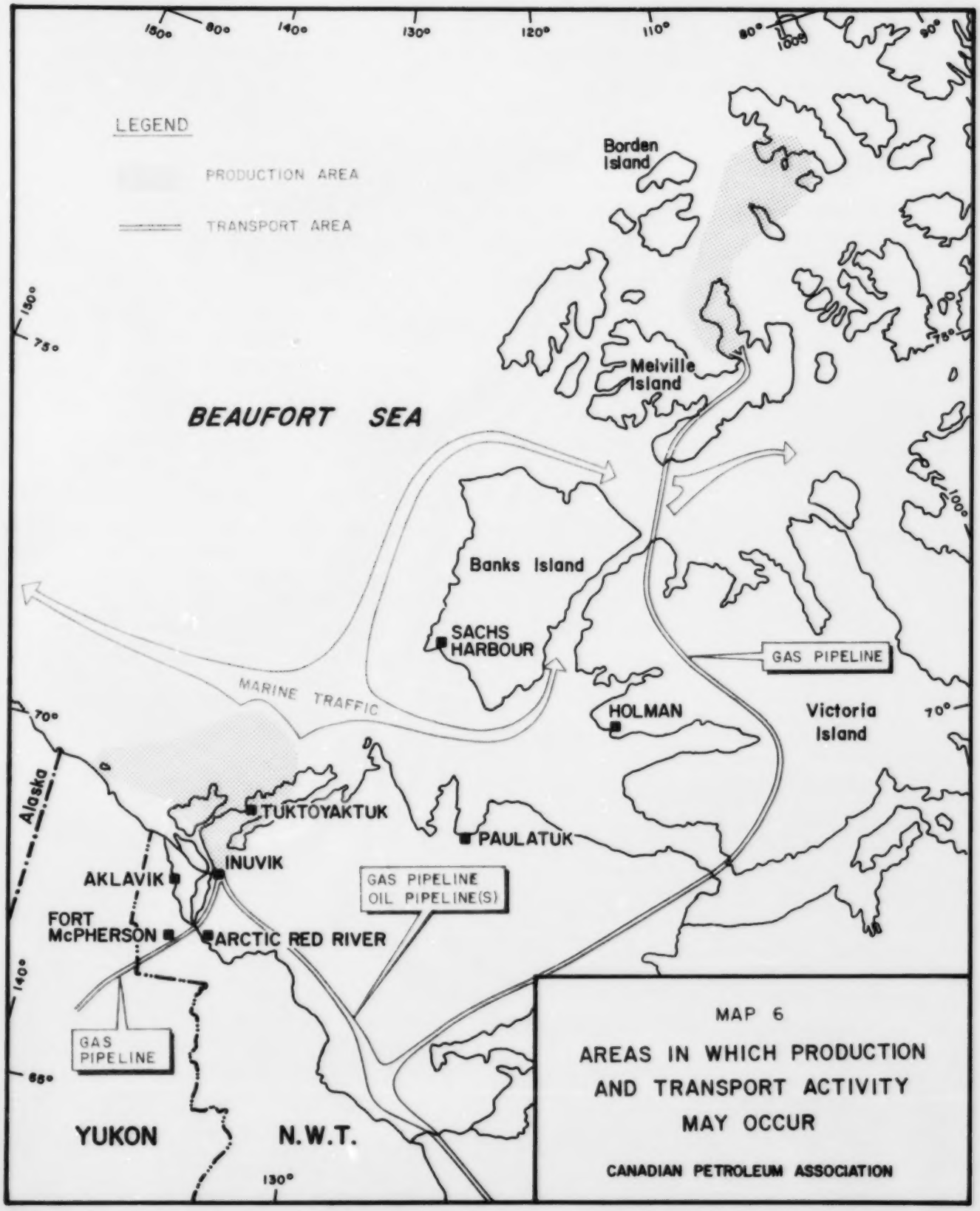
Proposals for Transporting Gas

Canadian Arctic Gas Study Limited first proposed the transport of natural gas reserves from the delta region via an Arctic Gas Pipeline. The Arctic

Gas Pipeline proposal was for a pipeline extending from Prudhoe Bay in Alaska, across the north slope region of Alaska and Yukon to the Mackenzie Delta. Canadian gas was to have been injected into the system at a point of interconnection in or near the delta, and from there transported together with American gas south along the Mackenzie River Valley. Plans for the Arctic Gas line were abandoned in 1977 when Canada's National Energy Board selected an alternate route along the Alaska Highway that was proposed by Foothills Pipe Lines Ltd.

Prior to proposing the Alaska Highway Pipeline, Foothills Pipe Lines Ltd. had for a period considered moving Canadian gas from the Delta region south along the Mackenzie River Valley in a proposed Maple Leaf Gas Pipeline. The Maple Leaf proposal, however, was dropped in favor of the Alaska Highway Gas Pipeline System which could move both American and Canadian gas reserves. The Alaska Highway system put forward by Foothills involves moving Alaskan gas from Prudhoe Bay south to Fairbanks and then south and east along the Alaska Highway to northern British Columbia, Alberta and to markets in the United States. Canadian gas is to be transported from the Mackenzie Delta to the mainline system via a lateral pipeline routed along the Dempster Highway and connecting with the mainline near Whitehorse, in Yukon Territory (**Map 6**). Foothills gained National Energy Board approval for its mainline Alaska Highway Gas Pipeline proposal and subsequently completed portions of the system in Alberta, British Columbia and Saskatchewan. A separate application for the Dempster lateral section of the Alaska Highway system is presently before the National Energy Board. At present, work on the Alaska Highway gas system has been halted because of uncertain energy prices.

A proposal to move northern Canadian gas reserves to market has also been put forward by the Polar Gas Project. The Polar Gas proposal would see reserves in the Mackenzie Delta moved south along the Mackenzie Valley via a pipeline routing similar to that proposed by Arctic Gas. A possible second phase of the Polar Gas Project would connect gas reserves in the Melville Island region to the Polar Gas mainline. Connection of the far northern reserves would be via a pipeline which would be routed from Melville Island and more northern gas fields, south across McClure Strait, Victoria Island, Dolphin and Union Strait and south-westward across the mainland territories to join the mainline system at a point near the community of Fort Norman (**Map 6**). The first phase of the Polar Gas Project is presently the subject of an application before the National Energy Board. Like the Alaska Highway Gas Pipeline proposal, work on the Polar Gas Project has been slowed by uncertain prices.



MAP 6

AREAS IN WHICH PRODUCTION AND TRANSPORT ACTIVITY MAY OCCUR

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Movement of natural gas from the planning region in a liquified form using ice-breaking or submarine tankers has been considered, but to date specific feasibility studies have not been completed.

Proposals for Transporting Oil

Proposals to move Mackenzie Delta and Beaufort Sea oil reserves to market have also been put forward. Among these are a proposal which involves marine transport using ice-breaking tankers, a proposal for a medium-sized oil pipeline routed along the Mackenzie River Valley and a proposal for a smaller oil pipeline, also routed along the Mackenzie River Valley, which would connect with the recently-completed oil pipeline from Norman Wells to Zama Lake in Alberta.

Marine tanker transport would involve the use of ice breaking tankers operating year round from loading terminals lying off the Beaufort Sea coast. The most likely route for oil tankers to and from the area would be through the Beaufort Sea eastward, using Amundsen Gulf and Prince of Wales Strait. An alternate route to the east could involve McClure Strait. Tankers might also move oil west through the Beaufort Sea to the Pacific via the Bering Sea (**Map 6**).

The proposed mid-sized oil pipeline would be designed to initially move oil reserves from the major offshore oil discovery at Amauligak south along the Mackenzie River Valley to existing pipeline facilities in Alberta (**Map 6**). Smaller offshore and onshore oil discoveries would be connected to the pipeline after a period of operation.

The smaller of the two proposed oil pipelines would be designed to carry hydrocarbon condensates from gas plants in the Mackenzie Delta and would connect with existing pipeline facilities at Norman Wells (**Map 6**). This pipeline would be implemented only if construction of the larger oil pipeline, described above, were to be delayed for a significant period of time after a gas pipeline system was in place.

Putting Transport Systems in Place

Not all of the transport systems proposed for moving hydrocarbons from the planning region will be built. Some, by their nature, preclude the necessity for others. It is unlikely, for example, that two pipeline systems to transport gas from the region would be built. The establishment

of one system would make a second unnecessary. In the case of the two oil pipeline systems proposed, however, it is possible, although unlikely, that both might be built. If gas development in the Mackenzie Delta were to precede oil development and the construction of a mid-sized oil pipeline by a number of years, the construction of a small oil line to carry liquid hydrocarbons produced as a by-product of gas production would be economic. If, on the other hand, a larger oil line was constructed before, or within a reasonable time after gas development, liquid hydrocarbons from gas processing would be injected into the larger line and plans for the smaller line abandoned. This latter scenario is considered the more likely of the two possibilities.

The possibility that both tanker and pipeline transport systems for oil and gas might be built also exists. In a situation where oil or gas was marketed in Europe or Japan, tanker transport would have obvious advantages, and this factor alone could make the development of more than one transport system appropriate.

The most likely scenario at the present time is that both a gas pipeline and an oil pipeline will be built before the end of the century and that tanker transport systems may follow.

From a land use planning perspective it is important to note that while the relatively large number of transport proposals cause some uncertainty, taken together, they clearly identify lands within the planning region that are important for use in transporting petroleum reserves. To the south, the Mackenzie River valley is an obvious overall transport corridor. Specific pipeline land-routes from the planning region have been proposed to the south along the Mackenzie Valley, and to the southwest along the Dempster Highway. Other access routes are being considered by some companies across northern Yukon Territory to Alaska. Marine transport to and from the region is possible to both the east and west.

It is not clear at the present time which of the several transport systems will be installed first, or in what order others may be required. Decisions to proceed with any of the transport systems will be made in response to world market conditions. Given the size of reserves already discovered in the planning region, and the undoubted long-term requirement for hydrocarbons, systems to transport both oil and gas must be anticipated in land use planning.

Production of Gas Reserves

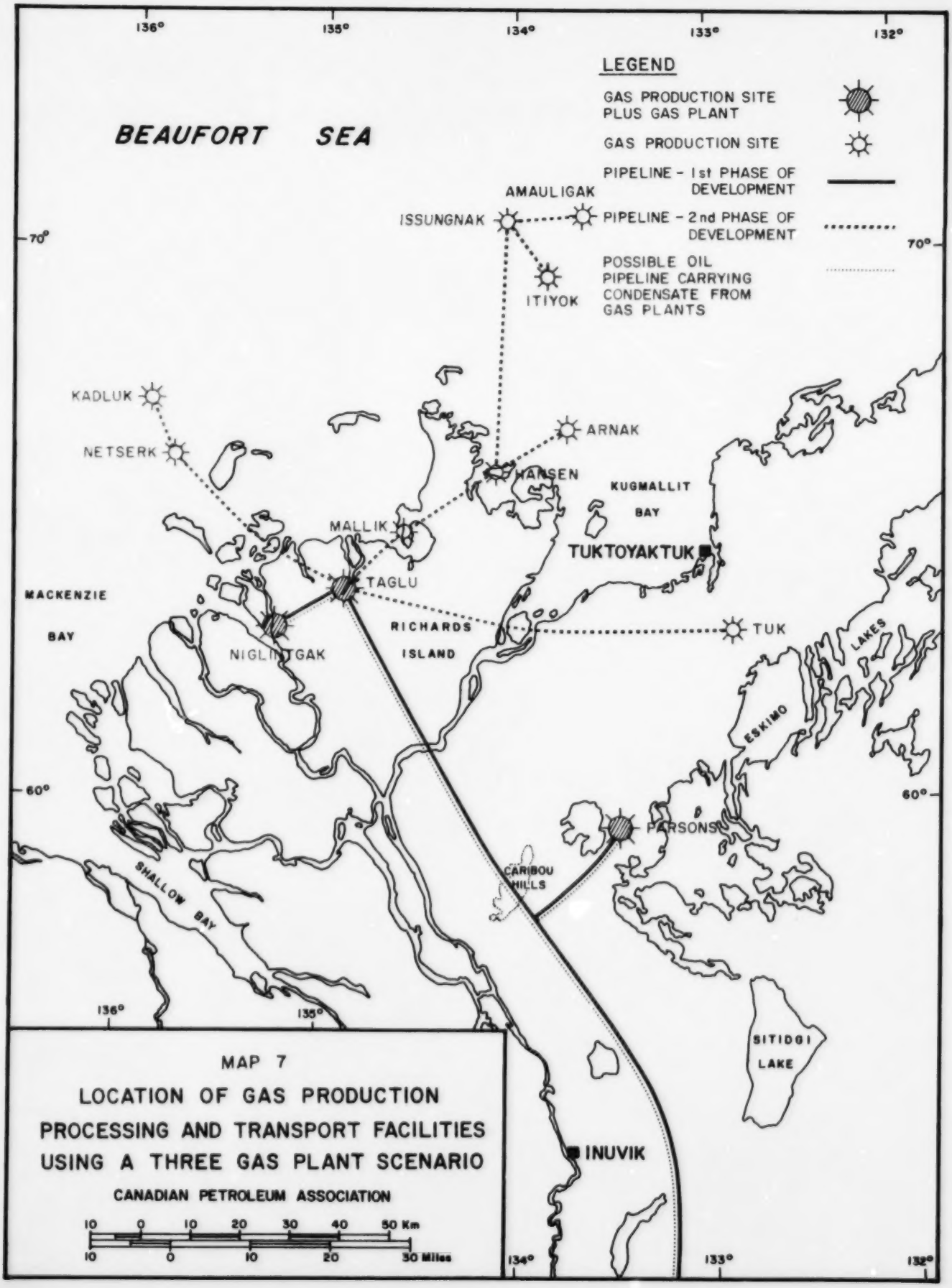
Proposals to move gas reserves from the planning region involve the construction and operation of large diameter gas transmission lines that would move gas to southern markets along one of two proposed routes. Production and processing facilities necessary to supply gas to either of the proposed gas pipeline systems would be similar in virtually all respects.

Gas production and processing facilities would likely be put in place first on land where major discoveries have been made. Production would then, over time, be extended to include smaller on-land reserves and offshore gas fields. Once processing and transport facilities for gas are in place, greatly increased efforts to discover more gas can be expected.

A likely scenario for initial gas development in the Mackenzie Delta region would see gas processing plants constructed first at Niglintgak and Taglu on Richards Island and at Parsons Lake on the mainland. Pipelines would connect the three plants to a gas transmission line to carry gas south. After several years of production from the three major onshore fields, (Niglintgak, Taglu and Parsons Lake) other reserves, located both on the delta and offshore, would be brought into production. Onshore reserves would likely be connected first because it would be less expensive to do so. Gas reserves which would be connected after the initial stage of development could include those at Kadluk, Netserk, Issungnak, Amauligak, Itiyok, Arnak, Hansen and Tuktoyaktuk. The locations of facilities involved in such a gas development scenario are shown on **Map 7**.

If, as expected, oil reserves in the region are developed before or within a similar time frame as gas reserves, natural gas produced at oil production sites would be moved to gas processing facilities, or to a nearby gas pipeline. In this regard it should be noted that the major oil discovery at Amauligak is associated with large reserves of gas.

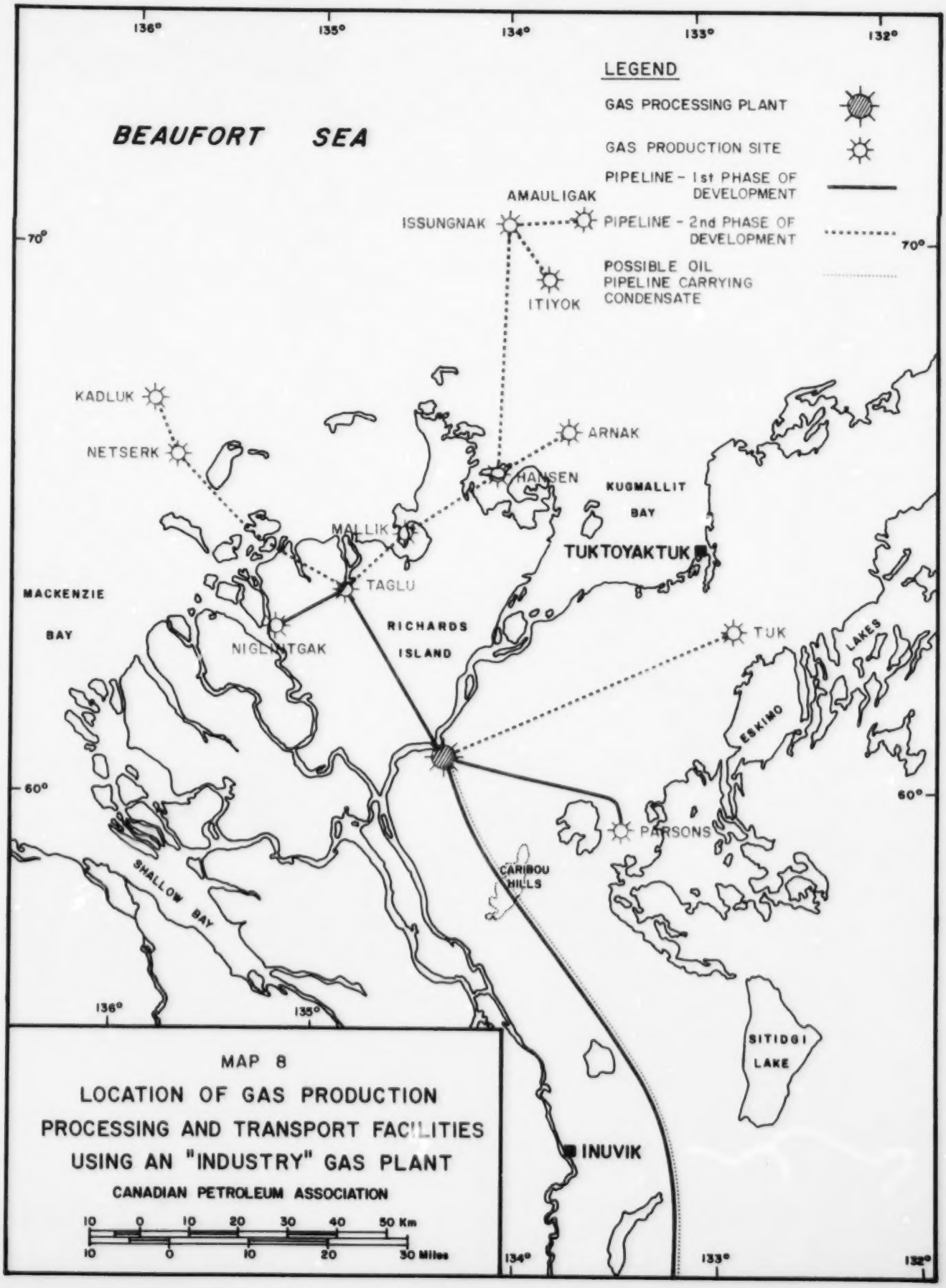
A possible variation on the development of gas plants at Niglintgak, Taglu and Parsons would be the establishment of an "industry" gas plant along the east channel of the Mackenzie River. If this approach were to be followed, gas reserves at the three main fields would be piped to the shared plant before processing. In later stages of development, other reserves, both on- and offshore, would also be connected via gathering lines designed to carry unprocessed gas. **Map 8** illustrates the likely location of gas



MAP 7

LOCATION OF GAS PRODUCTION PROCESSING AND TRANSPORT FACILITIES USING A THREE GAS PLANT SCENARIO

CANADIAN PETROLEUM ASSOCIATION


136°
135°
134°
133°
132°
LEGEND
GAS PROCESSING PLANT
GAS PRODUCTION SITE
PIPELINE - 1st PHASE OF DEVELOPMENT
PIPELINE - 2nd PHASE OF DEVELOPMENT
POSSIBLE OIL PIPELINE CARRYING CONDENSATE
BEAUFORT SEA
AMAULIGAK
ISSUNGNAK
ITIYOK
70°
KADLUK
NETSERK
ARNAK
HANSEN
KUGMALLIT BAY
MALLIK
TUKTOYAKTUK
TAGLU
MACKENZIE BAY
RICHARDS ISLAND
NIGLINTGAK
TUK
LAKES
ESKIMO
60°
PARSONS
CARIBOU HILLS
SHALLOW BAY
SITIDGI LAKE
INUVIK
MAP 8
LOCATION OF GAS PRODUCTION PROCESSING AND TRANSPORT FACILITIES USING AN "INDUSTRY" GAS PLANT
CANADIAN PETROLEUM ASSOCIATION
10 0 10 20 30 40 50 Km
10 0 10 20 30 Miles

development facilities within the planning region if such an "industry" gas plant scenario were to occur.

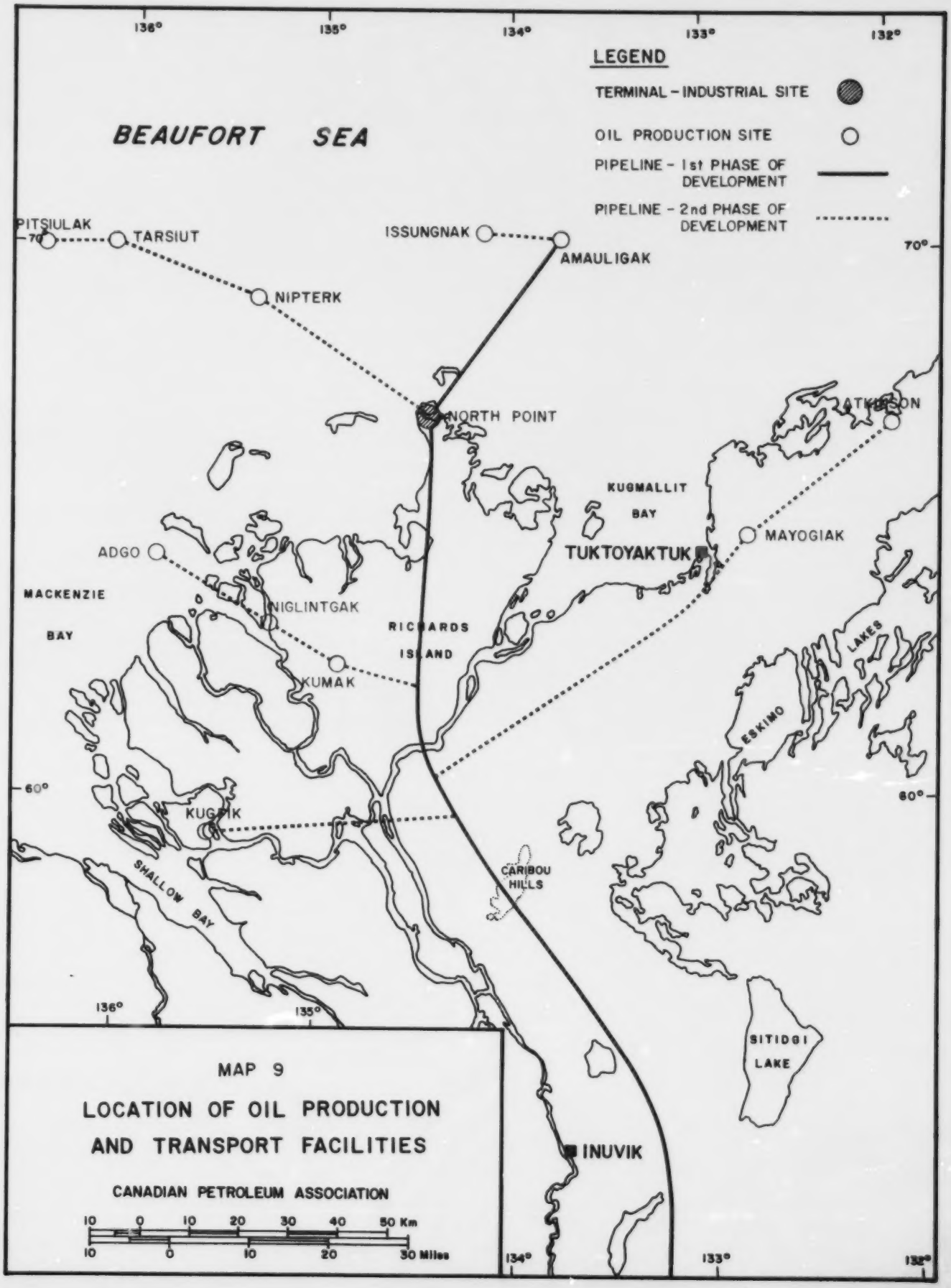
Production of Oil Reserves

It is likely that development of oil reserves in the Mackenzie Delta-Beaufort Sea area will initially involve production from the major oil discovery at Amauligak. Offshore production facilities will be put in place at the discovery site and a subsea pipeline will take the oil ashore. The most likely location for the offshore pipeline to make a landfall is at North Point on Richards Island (**Map 9**). Onshore facilities to receive, condition, store and pump the produced oil will be required at North Point. After production and transport systems to move oil from Amauligak are in operation, oil reserves at nearby discovery sites would be connected, either to a receiving terminal at North Point, or through gathering lines directed to convenient points of interconnection along the oil pipeline. Discoveries likely to be connected in a second phase of development are those on land, which include Adgo, Niglintgak, Atkinson and Kugpik. After onshore reserves are brought into production, attention would be paid to smaller discoveries offshore. Some of the latter would be connected through separate offshore gathering lines directed to North Head. Others, such as Issungnak, would be connected to North Point via existing gathering lines. The locations of facilities likely to be installed to expedite production of oil reserves in the Mackenzie Delta-Beaufort Sea are illustrated on **Map 9**.

As with gas development outlined in the previous section, exploration activities can be expected to intensify, once a firm decision to proceed with an oil line is announced.

FUTURE PETROLEUM-RELATED LAND USE IN THE PLANNING REGION

In the future, the petroleum industry will require land for continued exploration, for construction of production and processing facilities, and for the construction and operation of pipelines or other transport and support systems.


136°
135°
134°
133°
132°
LEGEND
TERMINAL - INDUSTRIAL SITE
OIL PRODUCTION SITE
PIPELINE - 1st PHASE OF DEVELOPMENT
PIPELINE - 2nd PHASE OF DEVELOPMENT
BEAUFORT SEA
PITSIULAK
TARSIUT
ISSUNGNAK
AMAULIGAK
NIPTERK
NORTH POINT
ATKINSON
KUGMALLIT BAY
ADGO
TUKTOYAKTUK
MAYOGIAK
MACKENZIE BAY
NIGLINTGAK
RICHARDS ISLAND
KUMAK
ESKIMO LAKES
KUGMIK
CARIBOU HILLS
SHALLOW BAY
SITIDGI LAKE
INUVIK
70°
60°
MAP 9
LOCATION OF OIL PRODUCTION AND TRANSPORT FACILITIES
CANADIAN PETROLEUM ASSOCIATION
10 0 10 20 30 40 50 Km
10 0 10 20 30 Miles

Land Use for Exploration

Land requirements and land uses associated with continued exploration in the region are not expected to be substantially different from those already experienced. Access to lands with hydrocarbon potential for seismic survey and exploration drilling will be required, as will be the use of appropriately-located land for support bases, camps, storage sites, airstrips and dock sites. Seismic surveys and exploration drilling could conceivably take place anywhere in the region, as virtually the entire area is underlain by sedimentary formations with a potential to contain hydrocarbons. However, over the next decade it is likely that most exploration will be centered on regions where exploration has occurred in the past and where hydrocarbons have already been found.

Land Use for Petroleum Production

Development of hydrocarbon reserves will require land at discovery sites for production drilling, and in some cases for processing or conditioning plants. Production will also require that lands be made available for transporting produced hydrocarbons to market. In onshore regions the latter requirement will translate primarily to a need for pipeline rights-of-way. On a local scale, production sites will have to be connected to processing plants by gathering lines. On a regional scale, lands will be required within corridors leading from sites where resources have been found. In offshore areas there will be a requirement for access to sea lanes through which marine traffic can pass. There will also be a requirement for land in offshore areas, in the form of seabottom, upon which to establish drilling and production structures.

Pipelines

Petroleum development in the region will require the installation and operation of a wide variety of pipelines ranging in size from small gathering lines of 50 to 100 millimetres in diameter to large transmission lines measuring as much as 1,000 millimetres in diameter. Land required for installation and operation of pipelines is a direct function of the size of pipe involved. Small diameter gathering lines can be installed by crews using limited equipment within the confines of rights-of-way 10 to 15 metres in width. In contrast, large diameter transmission lines require hundreds

of men using specialized heavy equipment and rights-of-way 30 or more metres wide.

Pipeline systems consist not only the pipe itself and a right-of-way in which to place it, but also facilities to pump product through the pipe. Pump stations (oil pipelines) or compressor stations (gas pipelines) are placed at intervals along the pipeline. The spacing chosen reflects specific design requirements of the pipeline system involved, but pump or compressor stations are usually situated from 50 to 100 kilometres apart.

Land requirements for pipelines may be both temporary and permanent. Land is required on a temporary basis for construction camps, stockpiling of pipe and equipment, access to the pipeline right-of-way during construction and in some cases, additional room along the right-of-way for construction purposes. During operation, the right-of-way itself, lands on which pump, compressor or meter stations are placed, and lands for a limited number of access routes to the right-of-way are required.

The area of land disturbed by pipeline construction along a right-of-way can vary from less than one hectare (2 acres) per kilometre for gathering lines to as much as 5 hectares (12 acres) for large transmission lines. Access roads, stockpile sites and compressor or pump stations may involve the use of another hectare (2 acres) per kilometre of line. After construction, rights-of-way are revegetated and land used for temporary facilities is reclaimed and revegetated.

Most pipelines used in future petroleum developments in the planning region will be buried. There is, however, a possibility that some gathering lines connecting production sites with processing facilities in the delta region will be positioned above ground. If used, such above-ground gathering lines would be supported on piles driven into the ground or by some form of berm.

Production Drilling

Drilling for production purposes will mirror exploratory drilling in most respects, but will involve larger areas of land, increased numbers of men and multiple drill rigs operating over extended periods of time. Production drilling in the Mackenzie Delta region will likely involve clusters of production wells drilled directionally from a single drilling pad or platform. More than one well cluster will often be required for the development of a single field, but the cluster drilling approach will reduce land disturbance. Similar cluster drilling techniques will likely be used

in offshore areas using appropriate platforms, which may include artifical islands or anchored offshore structures.

At most production well clusters some form of processing equipment will be needed. The complexity of processing at a particular production site will vary widely. At some there may only be simple water separators or pumping equipment. At others, major treatment facilities up to and including large gas processing plants may be put in place.

Land required for a simple production cluster is expected to be in the order of four to five hectares (10 to 12 acres). Where a number of clusters are required to properly develop a field, all-season road access to each cluster will likely be put in place. It is estimated that such a multi-cluster situation might require 20 to 40 additional hectares of land for access roads.

Processing

Processing of produced hydrocarbons is in most cases necessary before the products can be efficiently transported. Processing of field gas involves the removal of liquid hydrocarbons and water (drying) before injection into gas pipelines. Processing of produced oil involves removal of gases and water. Water removed by processing is usually disposed of through injection into disposal wells drilled for that purpose. Fluid hydrocarbons produced at gas processing facilities may be used as fuel on site, piped to adjacent oil transport facilities, or injected back into the reservoir. Similarly, gas produced at oil processing sites can be used on-site, piped to market if facilities exist, or returned to the reservoir.

Development of gas and oil reserves in the Mackenzie Delta and southern Beaufort Sea area will require a number of processing facilities. Development of gas reserves may require placing gas processing plants at two sites on Richards Island and a third near Parsons Lake, or alternatively, a single shared gas plant located along the east channel of the Mackenzie River. Oil development to support a mid-sized oil pipeline will require processing facilities at an offshore production site, in the initial stage of development, and possibly at or near an onshore pipeline terminal during subsequent development. Production of oil for transport by tanker ship will require processing facilities at offshore production sites.

At present it is not clear how much land might be required for the construction and operation of the processing facilities proposed but any

large facility will likely require permanent housing for workers, storage areas, docks and an airstrip. Gravel resources in the region are limited and the costs of moving gravel is high. As a result, additional efforts to locate suitable sources will be required, and designs that limit the amount of gravel required at onshore production and processing facilities will be given close attention.

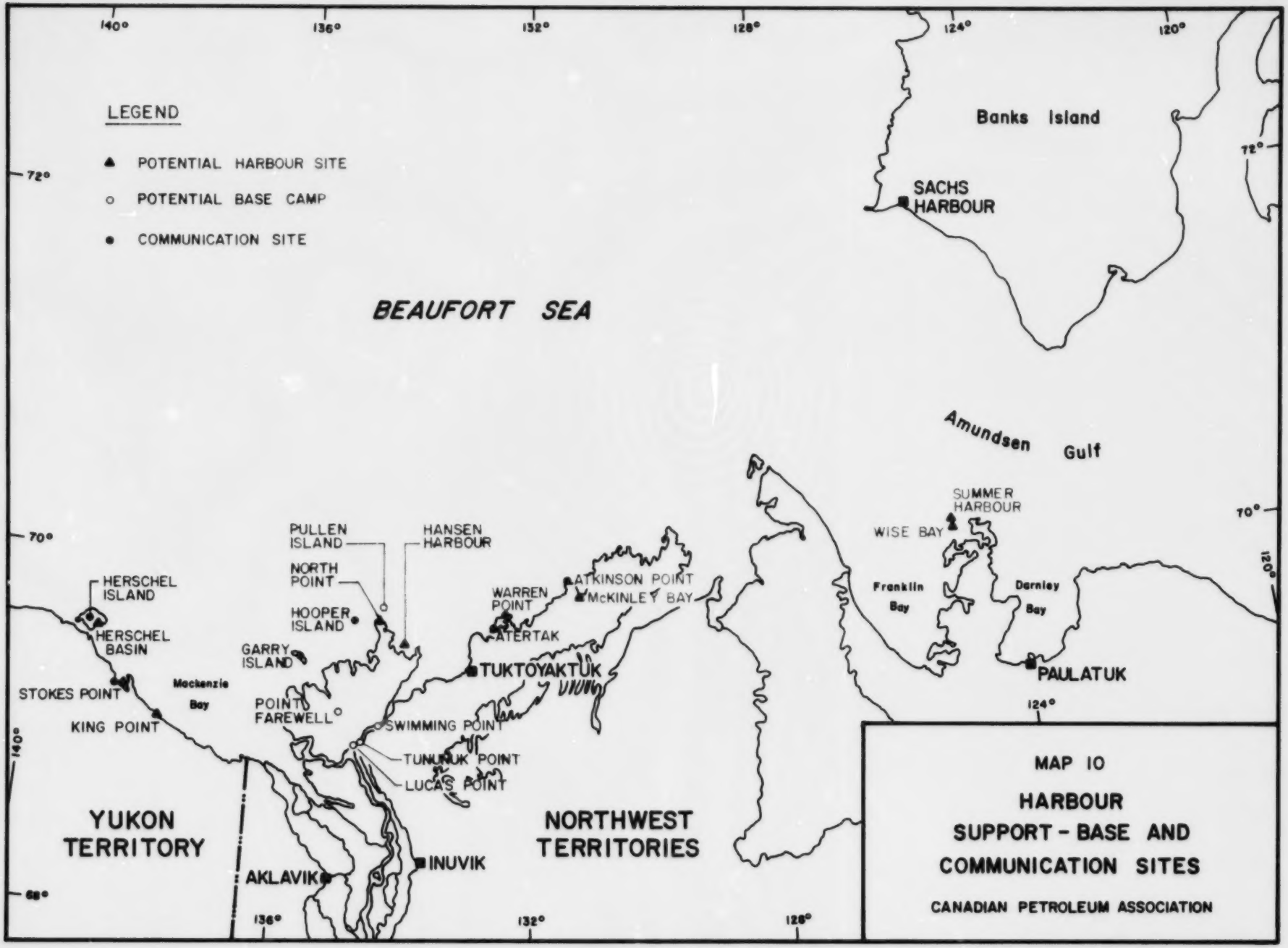
One possible design approach would be to mount processing equipment on barges and float the barges to an appropriate site along river channels. Once on site the barges would be placed within a specially-excavated lagoon, which would then be isolated from the river channel using an earthen dam and pumped dry, leaving the barge firmly in position for use. A reversal of the process would allow processing facilities to be moved elsewhere. Land use requirements for processing facilities designed in this way would be significantly reduced compared to an installation using gravel pads.

Land Use for Support Facilities and Activities

Production of gas and oil reserves will create a requirement for lands in addition to those dedicated to production, processing and transport. Land for support bases, harbours, sea lanes, temporary and permanent roads, waste disposal sites, communications installations, wharves, stockpile sites and airstrips will be needed. In addition, requirements for local resources such as gravel will entail the use of land.

Camps and Support Bases and Harbours

Many if not all of the camp sites, support bases and harbours previously used to support exploration activity in the Mackenzie Delta-Beaufort Sea area will likely continue to be used during the development phase (**Map 10**). Camp, storage, transhipment and communications facilities in the communities of Inuvik and Tuktoyaktuk will certainly play an important role in future development. Previously used camp and staging areas at Tununuk Point, Point Farewell, Swimming Point, Lucas Point and Pullen Island, will also be logical locations to place future camps or storage/staging facilities (**Map 10**). Offshore development may require base camp and support facilities at harbours along the Beaufort Sea coast. While there are no firm plans for cooperative development of support bases, it is likely that major offshore support facilities will be developed jointly by operators in the region. Such shared facilities could be developed at North Point or Hansen Bay on Richards Island, or at King Point or Stokes Point on



MAP 10

HARBOUR SUPPORT - BASE AND COMMUNICATION SITES

CANADIAN PETROLEUM ASSOCIATION

the western shore of Shallow Bay (**Map 10**). Other harbours used previously during exploration would likely continue to be used. The latter include Tuktoyaktuk, McKinley Bay, Summers Harbour, Wise Bay and Herschel Basin.

Roads

During the exploration phase of petroleum development in the planning region industry used only temporary ice and snow roads. While it is unlikely this general approach will change during future hydrocarbon development a need for all-season roads linking production clusters and paralleling some gathering lines may arise. At present, no requirements for all-weather roads along major pipeline routes is envisioned. A haul road from either Stokes Point or King Point, on the Beaufort Sea coast, to a quarry site in the foothills of the British Mountains may be constructed, if one of these proposed port sites is developed. Roads might also be constructed to reach and service communication and navigational aid sites along the Beaufort Sea coast.

Communications Sites

Increased requirements for radio communications and navigational aids will be part of future petroleum activity in the planning region. Some navigation systems require the placement of transceiving equipment at prominent, preferably elevated, points along the coast and such sites are in short supply. Continued access to communications sites at Herschel Island, Stokes Point, Garry and Hooper Islands, Atkinson Point, Warren Point and at Atertak, near Tuktoyaktuk, will assist further petroleum activity (**Map 10**).

Sea Lanes

Shipping routes leading northeast and west from the Beaufort Sea will be essential if offshore oil reserves are taken to market by tankers.

Waste Disposal Sites

To date, disposal of wastes arising from exploration activity has been governed by land use regulations. In some instances, the existing

regulations have been inadequate to meet the waste disposal requirements that have arisen. Those difficulties, combined with increased concern about waste disposal practices, particularly those involving wastes considered hazardous, will make an effective waste management system a priority for local authorities. Petroleum industry waste disposal requirements will include off- and onshore disposal sites for inert materials and for industrial and hazardous wastes.

Gravel

Past petroleum-related activity in the Mackenzie Delta area has relied in part on the use of local supplies of gravel. The gravel was used to construct working pads of sufficient thickness to insulate underlying permafrost and thereby ensure a firm foundation for drilling and other activities on a year-round basis. While efforts are being made to design production and processing facilities in a way that will minimize the need for gravel, there will nevertheless be a substantial future requirement for this relatively scarce local resource. Gravel, or lack of it, may affect the location and design of facilities required to develop the planning region's hydrocarbon resources. As petroleum development proceeds, there will be increasing demands on existing supplies of gravel, and intense efforts to find additional deposits.

THE PETROLEUM INDUSTRY AND LAND USE PLANNING

Member companies within the Canadian Petroleum Association have worked in the Mackenzie Delta-Beaufort Sea regional planning area for 30 years and have been directly involved in the evolution of land use practices in the region. The association believes that the land use planning proposed by the Commission will be beneficial to the region's people and to the efficient development of the region's resources. Properly executed, a regional land use plan will guide and expedite industry activity and at the same time give assurance to residents that their own land use needs are being protected.

The Association hopes to assist the planning commission by supplying information about industry activity and by keeping member companies that are active in the area fully informed concerning the planning process. In doing so, the association hopes to make clear the importance of petroleum resources in the region to member companies and at the same time to underscore the important role that development of those resources will play in maintaining and strengthening the region's economic health.

The petroleum industry has in the past been an active user of land in the region and has, over 30 years, discovered important oil and gas reserves. In order for those petroleum resources to be fully developed industry will require continued use of lands. Land having the potential to contain petroleum must continue to be made available for exploration, and reasonable access to such lands needs to be assured. On a larger scale, access to land over which resources can be moved out of the region must also be maintained. Finally, access to and use of certain lands uniquely valuable to the petroleum industry must be protected from encroachment by incompatible land uses. Lands in the latter category include sites where significant petroleum discoveries have been made, deep water harbour sites along the Beaufort Sea coast and certain communications sites with unique physical characteristics.

Based on the experience of member companies elsewhere in North America, the Canadian Petroleum Association recommends to the commission a concept of multiple land use planning which allows the greatest number of compatible land uses for any site or area. Petroleum-related activities have, with careful planning and scheduling, been successfully implemented together with a wide range of other sensitive land uses in other parts of North America. Similar successful integration of land uses should be the objective of the planning process now being undertaken by the Commission. Achieving that objective may not be particularly difficult. A number of efforts to closely examine potential land use conflicts between petroleum activity and other land uses within the planning region has in fact led those involved to conclude that petroleum activity is not likely to cause undue disruption. Justice Thomas Berger recommended that a pipeline down the Mackenzie Valley be delayed, not because of possible land use conflicts, which he examined closely, but rather, because he believed residents of the region required time to prepare for the increase in economic activity that would accompany pipeline construction. Subsequent close examination of potential environmental effects and land use conflicts which led to the development of a Beaufort Environmental Monitoring Program (BEMP) and a Mackenzie Environmental Monitoring Program (MEMP), also resulted in the conclusion that few significant land use conflicts between petroleum activity and other land uses in the region are likely to occur. Finally, the recent completion and operation of oil production facilities near Norman Wells, and the pipeline system connecting those resources to market, clearly indicates petroleum activity can be carried out in the north without undue disruption to existing land uses. Monitoring reports completed annually for the Norman Wells pipeline underscore that point.

The experience of Canadian Petroleum Association members also suggests that land use plans should incorporate a good deal of flexibility and a clearly-defined process for review and refinement. Because all planning is based on predictions about the future and because today's best predictions often prove to be wrong, two kinds of difficulty may arise. On the one hand, some anticipated land use conflicts may fail to occur, while on the other, completely unexpected conflicts may arise. If the approach taken to planning prevents planners or land users from adjusting to such unexpected developments, land users may suffer. In short, a good land use plan needs to be flexible enough to allow resolution of land use conflicts which are not predicted, and equally, to adjust established procedures when predicted conflicts fail to occur.

In conclusion, it should be noted that in preparing this report, the association has attempted to bring together information which represents the interests and the plans of many member companies. In doing so, the specific interests of some companies has of necessity been dealt with incompletely. Because individual companies may have significant land use requirements that may be directly affected by planning decisions, the commission may wish to seek information directly from the member firms, or may wish to put in place arrangements whereby individual firms can present their land use plans and requirements in detail. Such an arrangement would ensure the commission has the best possible information when developing land use plans for the region.